

# Claims

- [c1] 1. A method for operating a hybrid vehicle having a primary power generating system and a secondary power generating system coupled via a power transmission assembly for delivery of tractive force for the vehicle, the method comprising:
- determining acceleration of input speed to the power transmission assembly when the primary power generating system is deactivated; and
- inferring activation of the primary power generating system based at least in part on the acceleration of the power transmission assembly.
- [c2] 2. The method set forth in claim 1 wherein the primary power generating system comprises an internal combustion engine, the secondary power generating system comprises an electric machine that performs as a motor in one mode of operation, and performs as a generator in another mode of operation;
- operating the hybrid vehicle comprises engine start detection and activation of the primary power generating system comprises engine start;
- determining acceleration of input speed to the power

transmission assembly comprises determining a transmission input speed, filtering the transmission input speed, determining a derivative of the filtered transmission input speed, and filtering the derivative of the filtered transmission input speed; and  
inferring activation of the primary power generating system comprises  
determining an engine speed and a transmission input torque;  
generating a first trigger signal when the filtered derivative of the filtered transmission input speed is greater than a first predetermined speed for a first predetermined time;  
generating a second trigger signal when the engine speed is greater than a second predetermined speed;  
generating a third trigger signal when the transmission input torque is greater than a predetermined torque level; and  
asserting an engine start signal when the first, second, and third trigger signals are substantially simultaneously generated.

- [c3] 3. The method set forth in claim 2 wherein the transmission input speed is filtered using a first second order low pass filter and the derivative of the filtered transmission input speed is filtered using a second second order low

pass filter.

[c4] 4. The method set forth in claim 2 further including the steps of:

determining an actual throttle position;

generating a fourth trigger signal when the derivative of the filtered transmission input speed is greater than a fourth predetermined speed;

generating a fifth trigger signal when the actual throttle position is greater than a predetermined position; and asserting the engine start signal when the fourth and fifth trigger signals are substantially simultaneously generated.

[c5] 5. The method set forth in claim 2 further including the steps of:

filtering the engine speed;

determining a difference between the filtered engine speed and the filtered transmission input speed;

filtering the difference between the filtered engine speed and the filtered transmission input speed; and

asserting the engine start signal when the filtered difference between the filtered engine speed and the filtered transmission input speed is greater than a fourth predetermined speed.

[c6] 6. The method set forth in claim 5 wherein the engine

speed is filtered using a third second order low pass filter and the difference between the filtered engine speed and the filtered transmission input speed is filtered using a first order low pass filter.

[c7] 7. The method set forth in claim 2 further including the steps of:

determining an engine clutch engagement; and  
asserting the engine start signal when the engine clutch is engaged for a duration greater than a second predetermined time.

[c8] 8. The method set forth in claim 1 wherein the primary power generating system comprises an internal combustion engine, the secondary power generating system comprises an electric machine that performs as a motor in one mode of operation, and performs as a generator in another mode of operation;

operating the hybrid vehicle comprises engine start detection and activation of the primary power generating system comprises engine start;

determining a filtered acceleration of input speed to the power transmission assembly comprises

determining a transmission input speed;

filtering the transmission input speed using a Kalman low pass filter;

filtering the Kalman filtered transmission input speed

using a first first order low pass filter; and  
inferring activation of the primary power generating system comprises  
determining a difference between the Kalman filtered transmission input speed and the first order filtered transmission input speed; and  
asserting an engine start signal when the difference between the Kalman filtered transmission input speed and the first order filtered transmission input speed is greater than a first predetermined speed.

[c9] 9. The method set forth in claim 8 further including the step of exponentially adjusting a filter constant of the first order filter in response to time from initiation of the method.

[c10] 10. The method set forth in claim 8 wherein the difference between the Kalman filtered transmission input speed and the first order filtered transmission input speed is determined using a combiner.

[c11] 11. The method set forth in claim 8 further including the steps of:  
determining engine speed;  
filtering the engine speed;  
filtering the transmission input speed using a first second order low pass filter;

determining a difference between the filtered engine speed and the second order filtered transmission input speed;

filtering the difference between the filtered engine speed and the second order filtered transmission input speed;

and

asserting the engine start signal when the filtered difference between the filtered engine speed and the second order filtered transmission input speed is greater than a second predetermined speed.

[c12] 12. The method set forth in claim 11 wherein the engine speed is filtered using a second second order low pass filter, and the difference between the filtered engine speed and the second order filtered transmission input speed is filtered using a second first order low pass filter.

[c13] 13. The method set forth in claim 8 further including the steps of:

determining an engine clutch engagement; and

asserting the engine start signal when the engine clutch is engaged for a duration greater than a predetermined time.

[c14] 14. A powertrain system for operating a hybrid vehicle, the system comprising:

a primary power generating system;  
a secondary power generating system coupled via a power transmission assembly for delivery of tractive force for the vehicle; and  
a controller configured to determine acceleration of input speed to the power transmission assembly when the primary power generating system is deactivated, and infer activation of the primary power generating system based at least in part on the acceleration of the power transmission assembly.

[c15] 15. A method for operating a hybrid vehicle having a primary power generating system and a secondary power generating system coupled via a power transmission assembly for delivery of tractive force for the vehicle, the method comprising:

determining speed of the secondary power generating system, and speed of the primary power generating system speed; and

inferring activation of the primary power generating system based at least in part on the absolute value of the difference between the speed of the primary power generating system and the speed of the secondary Power generating system.

[c16] 16. The method set forth in claim 15 wherein the primary power generating system comprises an internal

combustion engine and the secondary power generating system comprises an electric machine that performs as a motor in one mode of operation, performs as a generator in another mode of operation, and performs as a starter in yet another mode of operation, and the speed of the secondary power generating system comprises a motor uni-directional speed; inferring activation of the primary power generating system; and activation of the primary power generating system comprises engine start; and inferring activation of the primary power generating system comprises determining an engine clutch engagement signal, and a filtered motor torque signal; determining a difference between a filtered engine speed signal and the motor uni-directional speed signal; determining the absolute value of the difference between the filtered engine speed signal and the motor uni-directional speed signal when the difference between the filtered engine speed signal and the motor uni-directional speed signal is less than a first predetermined speed; generating a first trigger signal when the absolute value of the difference between the filtered engine speed signal and the motor uni-directional speed signal is less than a second predetermined speed;



rounding the clutch engagement signal and generating a second trigger signal;  
generating a third trigger signal when the filtered motor torque signal is less than a predetermined torque; and  
asserting an engine start signal when the first, second, and third trigger signals are substantially simultaneously generated for a first predetermined time.

[c17] 17. The method set forth in claim 16 further including the steps of:

waiting for the predetermined time; and  
asserting an engine start signal when the first, second, and third trigger signals are substantially simultaneously generated for the first predetermined time.

[c18] 18. The method set forth in claim 16 further including the step of asserting the engine start signal when the engine clutch is engaged for a duration greater than a second predetermined time, and the second predetermined time has a longer duration than the first predetermined time.

[c19] 19. The method set forth in claim 16 wherein the filtered engine speed signal is a second order low pass filtered version of an engine speed signal.

[c20] 20. The method set forth in claim 16 further including

the steps of:

determining an transmission input speed

filtering the transmission input speed using a second order low pass filter;

determining a difference between the filtered engine speed and the second order filtered transmission input speed;

filtering the difference between the filtered engine speed and the second order filtered transmission input speed;  
and

asserting the engine start signal when the filtered difference between the filtered engine speed and the second order filtered transmission input speed is greater than a third predetermined speed.